4.3.7.2.3 Shut Down and Maintain

Aesthetic impacts under this alternative would be the same as those noted for the Shut Down and Deactivate Alternative, except DOE could restart the River Water System if necessary. Section 3.3 contains possible reasons for restarting the system.

4.3.8 OCCUPATIONAL AND PUBLIC HEALTH

4.3.8.1 Affected Environment

Releases from R-Reactor in the form of process leaks, purges, and makeup cooling water have contaminated Par Pond with low levels of radioactive materials, primarily cesium-137 [originally 222 curies in Par Pond, the R-Reactor canals, and Lower Three Runs (DOE 1995a)]. All radiological releases except tritium stopped after the shutdown of R-Reactor in 1965. Most of the cesium-137 resides in the upper 1 foot (0.3 meter) of fine sediments, in the original stream corridors. Because its half-life is 30 years, more than half of the cesium-137 associated with Par Pond has decayed since the releases occurred [currently about 43 curies remain in Par Pond, more than two-thirds below the 190-foot (57-meter) level]. Elevated levels of mercury have accumulated in sediments from water pumped from the Savannah River (DOE 1995c).

In 1995 DOE completed an environmental assessment that enabled the cessation of pumping from the River Water System to Par Pond. Until that time, DOE had maintained the water level in Par Pond at full pool [approximately 199.2 feet (59.7 meters)] with the addition of flow from the River Water System. DOE stopped the pumping to reduce operating costs and, as a result, Par Pond water levels fluctuate naturally, depending only on rainfall and groundwater recharge. As a result, the surface-water level of Par Pond is likely to fluctuate naturally from a full pool of approximately 199.2 feet (60.7 meters) to 196 feet (59.7 meters) exposing about 340 acres (1.4 square kilometers) of sediment (Figure 4-36) (DOE 1995a).

DOE collected samples from the exposed sediments of Par Pond in early 1995, shortly before refilling the reservoir after the drawdown. The sampling was confined to elevations between 190 and 200 feet (58 and 61 meters) above mean sea level, which included sediments likely to be exposed when the water level can fluctuate naturally, as expected under the alternatives. The sediments were analyzed for a number of radionuclides and metals. Some of the soil samples were analyzed for organic contaminants, none of which were detected above EPA or Canadian screening criteria for contaminants in terrestrial soils (Paller and Wike 1996b).

DOE detected a number of radionuclides in the Par Pond sediments, but only cesium-137 occurred consistently and at levels well in excess of levels at the control sites. The geometric mean concentration of cesium-137 was 7.2 picocuries per gram; the maximum was 56.7 picocuries per gram (Paller and Wike 1996b).

DOE detected mercury in exposed dry sediments in concentrations high enough to be of possible concern. Mercury concentrations were characterized by a geometric mean and maximum levels of 62 and 485 micrograms per kilogram, respectively.

4.3.8.2 Environmental Impacts

The 1995 environmental assessment (DOE 1995a) estimated human health impacts from a natural fluctuation in Par Pond. However, DOE calculated these impacts in accordance with guidance provided by the EPA (EPA 1989), and limited them to individuals working and living (residential scenario) close to contaminated sediments. The impacts, therefore, represent a conservative upper bound of risk probability.

Impacts calculated for this EIS are based on more realisti : exposure parameters (e.g., people are assumed to not live close to contaminated sediments). In addition, this EIS projects impacts to remote receptors (e.g., uninvolved workers, offsite maximally exposed individual) with the use of analytical computer codes [MEPAS (Droppo et al. 1995)] to estimate environmental transport. Finally, risk probabilities calculated for the environmental assessment relate only to the incidence (morbidity) of cancer resulting from exposures to radionuclides, whereas this EIS estimates the probability of latent fatal cancers (mortality) resulting from exposure to radiological constituents as well as hazard indexes and cancer morbidity resulting from exposures to nonradiological constituents.

4.3.8.2.1 No Action

For the No-Action Alternative, the surface water level of Par Pond would fluctuate naturally from full pool of approximately 200 feet (61 meters) to 196 feet (59.7 meters), exposing about 340 acres (1.4 square kilometers) of sediment (Figure 4-36) (DOE 1995a). The level would remain at about 198.4 feet (59.7 meters) 75 percent of the time (Gladden 1996a), exposing only about 114 acres (0.5 square kilometer) of sediment. These sediments would dry and become resuspended in the atmosphere, available for inhalation by onsite workers and the offsite population within 50 miles (80 kilometers) of the SRS. In addition, the contaminated sediments would provide direct pathways for current and future land use scenarios to the involved workers.

To provide a realistic and not overly conservative analysis, concentrations (Paller 1996) were averaged over the average exposed areas (Gladden 1996c) of dry sediment to use as input parameters to the MEPAS computer code.
TE | Table 4-55 lists spatially averaged concentrations and the resulting inventory from this evaluation.

Although tritium is present in Par Pond surface waters [1.0 picocurie per milliliter (Simpkins 1996c)], this EIS does not evaluate volatilization, atmospheric transport, and exposure through inhalation of this radioisotope for Par Pond because incremental changes in impacts would be extremely small in comparison to the other impacts evaluated. This is because the quantity of tritium volatilized from the surface water is directly proportional to the total area of surface water exposed to the atmosphere, and this area has changed only slightly from baseline conditions due to previous NEPA actions.

Due to the elevated levels of mercury and cesium-137 identified in Par Pond sediments, DOE does not anticipate that future land use scenarios would include recreational use by members of the public without some level of remediation. Because DOE does not know the required degree of remediation, it cannot calculate potential impacts from future land use by members of the public. However, the future land use scenario for onsite industrial workers assumes no remediation.

Public Health Impacts

<u>Radiological Impacts</u>

To estimate the health effects associated with the No-Action Alternative on the public, radiological doses for the current land use scenario were calculated to the maximally exposed individuals and population groups. For Par Pond, only atmospheric releases from exposed sediments were evaluated because incremental changes to water releases through the dam would be very small. Therefore, this EIS does not calculate doses and resulting impacts from liquid releases for members of the public.

TE | Table 4-56 lists calculated doses resulting from atmospheric releases under the current land use scenario. The annual doses (6.5×10^{-6} rem to the offsite maximally exposed individual and 2.3×10^{-3} person-rem to the offsite population) would be small fractions of the doses from total SRS releases in 1995 [0.20 millirem to the maximally exposed member of the public and 5.1 person-rem to the population (Arnett, Mamatey, and Spitzer 1996)].

Table 4-55. Average concentrations and inventory of radionuclides and metals in Par Pond sediments.[a] TE

Radionuclides	Concentration (pCi/g)	Inventory (curies)
Cesium-137	*10.9*	2.41
Cobalt-60	0.04	0.0088
Metals	(ug/kg)	(grams)
Mercury	76.9	1.70×10^4
Thallium	4.1	9.05×10^2
Manganese	169	3.73×10^4

a. Source: Paller and Wike (1996a).\

Table 4-56. Radiological doses and resulting impacts associated with the No-Action Alternative and resulting health effects to the public.[a]

	Individual		Population	
Receptor(s)[b]	Total dose (rem)	Probability of fatal cancer	Total dose (person-rem)	Number of fatal cancers
Offsite maximally exposed individual				
Annual	6.5×10^{-6}	3.3×10^{-9}	NA[c]	NA
Lifetime[d]	2.3×10^{-4}	1.1×10^{-7}	NA	NA
Population				
Annual	NA	NA	2.3×10^{-3}	1.1×10^{-6}
Lifetime[d]	NA	NA	7.6×10^{-2}	3.8×10^{-5}

a. Supplemental information provided in Tables C-35 and C-36 in Appendix C.
b. The doses to the public from total SRS operations in 1995 were 0.20 millirem to the offsite maximally exposed individual (0.06 millirem from airborne releases and 0.14 millirem from aqueous releases) and 5.1 person-rem to the regional population (3.5 person-rem from airborne releases and 1.6 person-rem from aqueous releases); Source: Arnett, Mamatey, and Spritzer (1996).
c. NA = not applicable.
d. Based on 70 years of exposure; doses are corrected for radioactive decay.

Nonradiological Impacts

Table 4-57 lists the hazard index associated with the No-Action Alternative. The calculated hazard index for the maximally exposed individual would be a small fraction of 1 and, therefore, this individual would not experience adverse health effects. TE

Occupational Health

Radiological Impacts

Doses to involved and uninvolved workers were estimated for the No-Action Alternative using the exposure assumptions discussed in Section 4.1.8.2.2. Table 4-58 lists the incremental TE

Table 4-57. Nonradiological, noncarcinogenic hazard index associated with the No-Action Alternative for members of the public.[a]

Receptor	Total hazard index
Offsite maximally exposed individual	1.5×10^{-4}

a. Supplemental information is provided in Table C-37 in Appendix C.

Table 4-58. Worker radiological doses associated with the No-Action Alternative and resulting health effects.[a]

Receptor(s)	Individual		All workers	
	Dose (rem)	Probability of fatal cancer	Dose (person-rem)	Number of fatal cancers
Involved worker[b] (current use)				
Annual[c]	4.2×10^{-4}	1.7×10^{-7}	2.9×10^{-2}	1.2×10^{-5}
Lifetime[d]	2.0×10^{-3}	7.9×10^{-7}	1.4×10^{-1}	5.5×10^{-5}
Involved worker[e] (future use)				
Annual[c]	2.3×10^{-2}	9.4×10^{-6}	1.6	6.5×10^{-4}
TC Lifetime[d]	4.4×10^{-1}	1.8×10^{-4}	3.1×10^{1}	1.2×10^{-2}
Uninvolved worker[f]				
Annual[c]	7.7×10^{-8}	3.1×10^{-11}	8.1×10^{-6}	3.2×10^{-9}
Lifetime[d]	1.4×10^{-6}	5.8×10^{-10}	1.5×10^{-4}	6.1×10^{-8}

a. Supplemental information provided in Tables C-38, C-39, and C-40 in Appendix C.
b. Estimated to be 70 workers.
c. Annual individual worker doses can be compared with the regulatory dose limit of 5 rem (10 CFR 835) and with the SRS administrative exposure guideline of 0.7 rem. Operational procedures ensure that the dose to the maximally exposed worker will remain as far below the regulatory dose limit as is reasonably achievable. Based on a total of 13,651 monitored workers (Kvartek 1996), the 1995 average dose for all site workers who received a measurable dose was 0.019 rem (See Table 4-15).
d. Based on 5 years of exposure for current workers and 25 years of exposure for future and uninvolved workers; doses are corrected for radioactive decay.
e. Estimated to be 70 workers.
f. L-Area; total uninvolved workers estimated to be 251 [Source: Simpkins (1996c)].

worker doses [the increase in dose due to activities prior to the Par Pond environmental assessment (DOE 1995a)]. These doses represent a small fraction of the DOE limit (10 CFR 835), which requires that annual doses to individual workers not exceed 5 rem per year, and a small fraction of the SRS administrative limit of 0.7 rem per year (WSRC 1995d).

Nonradiological Health

Nonradiological health impacts (hazard index) were calculated under the current and future land use scenarios for the involved worker. The exposure pathways and exposure times would be the same as those discussed in Section TE 4.1.8.2.1. Table 4-59 lists the results; the

Table 4-59. Worker nonradiological hazard indexes associated with the No-Action Alternative.[a]

Receptor(s)	Total hazard index
Involved worker (current use)	3.1×10^{-5}
Involved worker (future use)	5.6×10^{-4}
Uninvolved worker[b]	1.5×10^{-8}

a. Supplemental information is provided in Tables C-41, C-42, and C-43 in Appendix C.
b. L-Area.

calculated hazard indexes for the maximally exposed involved worker under the current and future land use scenarios would be a small fraction of 1. Therefore, these individuals would not experience adverse health effects.

For the uninvolved worker, assumed to be in L-Area, the calculated hazard index would be a very small fraction of 1 and, therefore, this individual would not experience adverse health effects.

4.3.8.2.2 Shut Down and Deactivate

For the Shut Down and Deactivate Alternative, Par Pond would maintain the same water levels as those described under the No-Action Alternative. Therefore, impacts to workers and members of the public under Shut Down and Deactivate would be the same as those under No Action.

4.3.8.2.3 Shut Down and Maintain

For the Shut Down and Maintain Alternative, Par Pond would maintain the same water levels as those described under the No-Action Alternative. Therefore, impacts to workers and members of the public under Shut Down and Maintain would be the same as those under No Action.

4.3.8.3 Combined Impacts

This EIS presents human health impacts from three separate sources: L-Lake, SRS streams, and Par Pond. Because some population groups would be affected by releases from more than one of these sources at the same time, DOE has combined these effects, where appropriate, to estimate the combined impacts. For example, offsite and uninvolved worker populations would be affected simultaneously from L-Lake and Par Pond atmospheric releases (Figure 4-37 shows release points). However, DOE did not add the impacts from remote facilities to involved worker impacts because it assumes they are separate work groups. The following sections discuss the assumptions used to estimate the combined impacts of these and other releases under each alternative.

4.3.8.3.1 No Action

Public Health Impacts

As described in Section 4.2.8.2.1, DOE did not calculate public health impacts associated with the No-Action Alternative for SRS streams. Therefore, the combined radiological and nonradiological impacts for members of the public under the No-Action Alternative would consist of the combination of the impacts listed in Tables 4-17, 4-18, 4-56, and 4-57. The following paragraphs describe impacts to the combined maximally exposed individual. TE

Radiological Impacts

Table 4-60 lists combined doses and resulting impacts to individuals and population groups for the No-Action Alternative. Under the current land use scenario, the maximally exposed individual was determined by normalizing atmospheric releases from L-Lake (tritium) and Par Pond to a center-of-Site reference and then TE

Table 4-60. Combined radiological doses and resulting impacts associated with the No-Action Alternative and resulting health effects to the public.[a]

Receptor(s)[b]	Individual		Population	
	Total dose (millirem)	Probability of fatal cancer	Total dose (person-rem)	Number of fatal cancers
Offsite maximally exposed individual (current use)				
Annual	6.6×10^{-3}	3.3×10^{-9}	NA[c]	NA
Lifetime[d]	2.3×10^{-1}	1.1×10^{-7}	NA	NA
Offsite maximally exposed individual (future use)[e]				
Annual	3.8×10^{-1}	1.9×10^{-7}	NA[c]	NA
Lifetime[d]	1.3×10^{1}	6.6×10^{-6}	NA	NA
Population				
Annual	NA	NA	3.6×10^{-3}	1.8×10^{-6}
Lifetime[d]	NA	NA	1.0×10^{-1}	5.0×10^{-5}

a. Supplemental information provided in Tables 44, 45, and 46 in Appendix C.
b. The doses to the public from total SRS operations in 1995 were 0.20 millirem to the offsite maximally exposed individual (0.06 millirem from airborne releases and 0.14 millirem from aqueous releases) and 5.1 person-rem to the regional population (3.5 person-rem from airborne releases and 1.6 person-rem from aqueous releases). Source: Arnett, Mamatey, and Spitzer (1996).
c. NA = not applicable.
d. Based on 70 years of exposure; doses are corrected for radioactive decay.
e. Assumes future recreational use of L-Lake.

adding the resulting impacts from each source facility. The combined maximally exposed individual was determined to reside in the east sector at the Site boundary.

For the future land use scenario, which assumes that only L-Lake would have future recreational use by members of the public, DOE determined the combined maximally exposed individual impacts by adding the future land use impacts for L-Lake with the current land use impacts for Par Pond.

The combined impacts to offsite populations were determined by adding the population doses and resulting impacts listed in Tables 4-17 and 4-56.

TE

Table 4-60 lists combined annual doses resulting from releases under the current land use scenario. The annual doses (6.6×10^{-3} millirem to the offsite maximally exposed individual and 3.6×10^{-3} person-rem to the offsite population) would be small fractions of the doses from total SRS releases to in 1995 [0.20 millirem to the maximally exposed member of the public and 5.1 person-rem to the population (Arnett, Mamatey, and Spitzer 1996)].

Under the future land use scenario, the annual dose (0.38 millirem) to the maximally exposed individual would be higher than under the current land use scenario but the resulting probability of developing a fatal cancer (1.9×10^{-7}) would still a be small fraction of the natural incidence of cancer from all causes. The annual population dose (3.6×10^{-3} person-rem) under future land use scenarios would remain unchanged from the current land use scenario. The offsite population receiving this dose for 70 years would be likely to develop 5.0×10^{-5} additional cancers. This is a small fraction of the number of cancers that would be expected in the same period of time from all causes (157,900) in the SRS 50-mile (80-kilometer) population.

Nonradiological Impacts

TE | Table 4-61 presents the combined hazard index for the maximally exposed individual under the current and future land use scenarios. For the current land use scenario, the maximally exposed individual is exposed only from atmospheric releases from exposed sediments of Par Pond. This hazard index (1.5×10^{-4}) was listed in Table 4-57. For the future land use scenario, the hazard index resulting from the future use of L-Lake (Table 4-18) would be added to the current use hazard index for Par Pond. As listed in Table 4-61, the combined hazard index would be less than 1. The cancer risk associated with exposure to beryllium in the surface water of L-Lake (3.1×10^{-7}) represents a small fraction of the natural incidence of cancer from all causes.

Occupational Impacts

To determine combined impacts to involved workers, DOE assumed that the impacts resulting from work around L-Lake would not be additive to those resulting from work around Par Pond because the involved workers for each source facility would represent a separate work group.

Radiological Impacts

Based on these assumptions, the combined impacts listed in Table 4-62 for the involved worker represent the greater of the doses and resulting impacts listed in Tables 4-19 and 4-58.

To estimate the combined impact for the uninvolved workers in L-Area, appropriate values from Tables 4-19 and 4-58 were summed.

As listed in Table 4-62, the combined probability that the involved worker would develop a fatal cancer sometime during his lifetime as the result of a single year's exposure to radiation under the No-Action Alternative and current land use scenario would be 1.7×10^{-7}. For the total involved workforce, the collective radiation dose could produce up to 1.2×10^{-5} additional fatal cancer as the result of a single year's exposure; over a 5-year career, the involved worker could have 5.5×10^{-5} additional fatal cancer as a result of exposure.

Under the future land use scenario, the combined probability that the average involved worker would develop a fatal cancer sometime during his lifetime as the result of a single year's exposure to radiation under the No-Action Alternative would be 9.4×10^{-6}, or approximately 1 in 100,000. For the total involved workforce, the collective radiation dose could produce up to 6.5×10^{-4} additional fatal cancer as the result of a single year's exposure; over a 25-year career, the involved workers could have 1.2×10^{-2} additional fatal cancer as a result of exposure.

The combined probability of any individual uninvolved worker developing a fatal cancer as a result of the estimated exposure would be 1.6×10^{-11}. For the total uninvolved workforce, the collective radiation dose could produce up to

Table 4-61. Combined nonradiological hazard indexes and cancer risk associated with the No-Action Alternative for members of the public.[a]

Receptor(s)[b]	Total hazard index	Annual (lifetime) latent cancer risk[c]
Offsite maximally exposed individual (current use)	1.5×10^{-4}	0
Offsite maximally exposed individual (future use)[d]	6.2×10^{-2}	3.1×10^{-7} (2.1×10^{-5})

a. See Tables C-47 and C-48 in Appendix C.
b. Includes direct exposure pathways.
c. Resulting from exposure to beryllium in L-Lake surface water.
d. Assumes future recreational use of L-Lake.

Table 4-62. Combined worker radiological doses and resulting impacts associated with the No-Action Alternative.[a] TE

Receptor(s)[b]	Individual		All workers	
	Dose (rem)	Probability of fatal cancer	Dose (person-rem)	Number of fatal cancers
Involved worker[b] (current use)				
Annual[c]	4.2×10^{-4}	1.7×10^{-7}	2.9×10^{-2}	1.2×10^{-5}
Lifetime[d]	2.0×10^{-3}	7.9×10^{-7}	1.4×10^{-1}	5.5×10^{-5}
Involved worker[b] (future use)				
Annual[c]	2.3×10^{-2}	9.4×10^{-6}	1.6[e]	6.5×10^{-4}
Lifetime[d]	4.4×10^{-1}	1.8×10^{-4}	3.1×10^{1}	1.2×10^{-2}
Uninvolved worker[f]				
Annual[c]	4.0×10^{-8}	1.6×10^{-11}	1.0×10^{-5}	4.0×10^{-9}
Lifetime[d]	6.5×10^{-7}	2.6×10^{-10}	1.6×10^{-4}	6.5×10^{-8}

TC

a. Supplemental information provided in Tables C-49 through C-54 in Appendix C.
b. Estimated to be 70 workers.
c. Annual individual worker doses can be compared with the regulatory dose limit of 5 rem (10 CFR 835) and with the SRS administrative exposure guideline of 0.7 rem. Operational procedures ensure that the dose to the maximally exposed worker will remain as far below the regulatory dose limit as is reasonably achievable. Based on a total of 13,651 monitored workers (Kvartek 1996), the 1995 average dose for all site workers who received a measurable dose was 0.019 rem (see Table 4-15). TE
d. Based on 5 years of exposure for current workers and 25 years of exposure for future and uninvolved workers; doses are corrected for radioactive decay.
e. Total for all involved workers; 1995 total for all workers was 256 person-rem (see Table 4-15). TE
f. L-Area; estimated to be 251 workers [Source: Simpkins (1996c)].

an additional 4.0×10^{-9} fatal cancer as the result of a single year's exposure; over a 25-year career, the uninvolved workers could have 6.5×10^{-8} additional fatal cancer. This is a small fraction of the natural incidence of cancer from all causes and would be, therefore, a minimal impact. TC TC

Nonradiological Impacts

The combined nonradiological health impacts (hazard index) and cancer risks were calculate for the current and future land use scenarios for the involved worker. The exposure pathways and exposure times would be the same as those discussed in Section 4.1.8.2.1. Table 4-63 lists the results; the calculated hazard indexes for the maximally exposed involved worker under the current and future land use scenarios would be a small fraction of 1. Therefore, these individuals would not experience adverse health effects. In addition, the cancer risk to the maximally exposed involved worker would be a small fraction of the natural incidence of cancer from all causes. TE

For the uninvolved worker assumed to be in L-Area, the combined hazard index of 1.5×10^{-8} is a very small fraction of 1 and, therefore, this individual would not experience adverse health effects attributable to exposure pathways after L-Lake dewatering.

4.3.8.3.2 *Shut Down and Deactivate*

This alternative would remove two sources of exposure from consideration: exposures due to tritium releases from L-Lake would stop because the lake would recede to the original Steel Creek corridor, and exposures due to future recreational use of L-Lake. In addition, although impacts from Par Pond would remain essentially

TE **Table 4-63.** Combined worker nonradiological hazard indexes and cancer risks associated with the No-Action Alternative.[a]

Receptor(s)[b]	Total hazard index	Annual (lifetime) latent cancer risk
Involved worker (current use)	2.1×10^{-4}	9.1×10^{-9} (4.5×10^{-8})
Involved worker (future use)	5.6×10^{-4}	1.3×10^{-8} (3.1×10^{-7})
Uninvolved worker[c]	1.5×10^{-8}	NA[d] (NA)

a. Supplemental information is provided in Tables C-55, C-56, and C-57 in Appendix C.
b. Nonradiological carcinogens are not released to the atmosphere.
c. L-Area.
d. NA = not applicable.

unchanged from those for the No-Action Alternative, the exposure of dry sediments in the L-Lake bed would create a new set of exposure pathways. The combined public and occupational health impacts are described in the following sections.

As described in Section 4.2.8.2.2, DOE did not calculate radiological and nonradiological public health impacts resulting from activities associated with SRS streams under the Shut Down and Deactivate Alternative. Therefore, as with the No-Action Alternative, public health impacts under this alternative would consist of a combination of impacts listed in Tables 4-21, TE 4-22, 4-56, and 4-57. These impacts were combined to determine the location and resulting impacts to the combined maximally exposed individual, and population doses were summed.

Public Health Impacts

Radiological Impacts

TE Table 4-64 lists the combined doses and resulting impacts to individuals and population groups for the Shut Down and Deactivate Alternative. The maximally exposed individual was determined by normalizing atmospheric releases from L-Lake and Par Pond to a center-of-Site reference and adding resulting impacts from each source facility. The combined maximally exposed individual would reside in the east sector at the Site boundary.

The combined impacts to offsite populations were determined by adding the population doses and resulting impacts listed in Tables 4-21 and 4-56.

TE

As listed in Table 4-64, the annual doses (6.9×10^{-3} millirem to the offsite maximally exposed individual and 2.7×10^{-3} person-rem to the offsite population) would be small fractions of the doses from total SRS releases to in 1995 [0.20 millirem to the maximally exposed member of the public and 5.1 person-rem to the population (Arnett, Mamatey, and Spitzer 1996)]. These doses would result in cancer probabilities much smaller than the natural probabilities of developing cancer from all causes.

Nonradiological Impacts

Under the Shut Down and Deactivate Alternative, the maximally exposed individual would be exposed to atmospheric releases from exposed sediments of L-Lake and Par Pond and liquid releases from sediment runoff from L-Lake. DOE determined the combined hazard index by adding the hazard index resulting

Table 4-64. Combined radiological doses associated with the Shut Down and Deactivate Alternative and resulting health effects to the public.[a] TE

Receptor(s)[b]	No Action: Total dose	No Action: Probability[c] or number of fatal cancer	Shut Down and Deactivate: Total dose	Shut Down and Deactivate: Probability[c] or number of fatal cancer
Offsite maximally exposed individual				
Annual (millirem)	6.6×10^{-3}	3.3×10^{-9}	6.9×10^{-3}	3.5×10^{-9}
Lifetime[d] (millirem)	2.3×10^{-1}	1.1×10^{-7}	2.4×10^{-1}	1.2×10^{-7}
Population				
Annual (person-rem)	3.6×10^{-3}	1.8×10^{-6}	2.7×10^{-3}	1.4×10^{-6}
Lifetime[d] (person-rem)	1.0×10^{-1}	5.0×10^{-5}	9.7×10^{-2}	4.9×10^{-5}

TC

a. Supplemental information provided in Tables C-58 and C-59 in Appendix C.
b. The doses to the public from total SRS operations in 1995 were 0.20 millirem to the offsite maximally exposed individual (0.06 millirem from airborne releases and 0.14 millirem from aqueous releases) and 5.1 person-rem to the regional population (3.5 person-rem from airborne releases and 1.6 person-rem from aqueous releases). Source: Arnett, Mamatey, and Spitzer (1996).
c. *For the offsite maximally exposed individual, probability of a latent fatal cancer; for the population, number of fatal cancers.*
d. Based on 70 years of exposure; doses are corrected for decay.

from L-Lake (Table 4-22) to the hazard index for Par Pond (Table 4-57). As listed in Table 4-65, the combined hazard index is a small fraction of 1 and, therefore, the exposed individual would not experience any adverse health effects. In addition, the combined cancer risk would represent a small faction of the natural incidence of cancer from all causes.

Occupational Health Impacts

For the Shut Down and Deactivate Alternative, DOE calculated occupational exposures to radiological and nonradiological constituents for L-Lake (see Tables 4-23 and 4-24), SRS streams (Tables 4-46 and 4-47), and Par Pond (Tables 4-58 and 4-59). To determine combined impacts to involved workers, DOE assumed that the impacts resulting from work around one facility would not be additive to those resulting from work around other facilities because the involved workers for each source facility would represent a separate work group. TE

<u>Radiological Impacts</u>

Based on these assumptions, the combined impacts listed in Table 4-66 for the involved worker represent the greater of the doses and resulting impacts presented in Tables 4-23, 4-46, and 4-58. DOE determined the combined impacts for the uninvolved workers in L-Area by adding the appropriate values from Tables 4-23 and 4-58 (uninvolved workers would not be impacted by SRS streams). TE TE TE

As listed in Table 4-66, the combined probability that the involved worker would develop a fatal cancer at some time as the result of a single year's exposure to radiation under the Shut Down and Deactivate Alternative and current land use scenario would be 1.7×10^{-7}, or approximately 2 in 10 million. For the total involved workforce, the collective radiation dose could produce up to 1.2×10^{-5} additional fatal cancer as the result of a single year's exposure; TE

Table 4-65. Combined nonradiological hazard index and cancer risks associated with the Shut Down and Deactivate Alternative for members of the public.[a]

	No Action	Shut Down and Deactivate	
Receptor(s)	Hazard index	Hazard index	Annual (lifetime) latent cancer risk[b]
Offsite maximally exposed individual	1.5×10^{-4}	2.2×10^{-1}	8.0×10^{-9} (5.6×10^{-7})

a. Supplemental information is provided in Table C-60 in Appendix C.
b. Resulting from inhalation of chromium and beryllium in contaminated sediments.

TE **Table 4-66.** Combined worker radiological doses associated with the Shut Down and Deactivate Alternative and resulting health effects.[a]

	No Action Alternative		Shutdown and Deactivate Alternative	
Receptor(s)	Dose	Probability[b] or number of fatal cancer	Dose	Probability[b] or number of fatal cancer
Involved worker (current use)				
Annual[c] (rem)	4.2×10^{-4}	1.7×10^{-7}	4.2×10^{-4}	1.7×10^{-7}
Lifetime[d] (rem)	2.0×10^{-3}	7.9×10^{-7}	2.0×10^{-3}	7.9×10^{-7}
All involved workers[e] (current use)				
Annual[c] (person-rem)	2.9×10^{-2}	1.2×10^{-5}	2.9×10^{-2}	1.2×10^{-5}
Lifetime[d] (person-rem)	1.4×10^{-1}	5.5×10^{-5}	1.4×10^{-1}	5.5×10^{-5}
Involved workers (future use)				
Annual[c] (rem)	2.3×10^{-2}	9.4×10^{-6}	4.1×10^{-2}	1.6×10^{-5}
Lifetime[d] (rem)	4.4×10^{-1}	1.8×10^{-4}	7.5×10^{-1}	3.0×10^{-4}
TC All involved workers[e] (future use)				
Annual[c] (person-rem)	1.6	6.5×10^{-4}	2.9	1.1×10^{-3}
Lifetime[d] (person-rem)	3.1×10^{1}	1.2×10^{-2}	5.2×10^{1}	2.1×10^{-2}
Uninvolved workers[f]				
Annual[c] (rem)	4.0×10^{-8}	1.6×10^{-11}	1.5×10^{-6}	5.9×10^{-10}
Lifetime[d] (rem)	6.5×10^{-7}	2.6×10^{-10}	3.5×10^{-5}	1.4×10^{-8}
All uninvolved workers[g]				
Annual[c] (person-rem)	1.0×10^{-5}	4.0×10^{-9}	3.7×10^{-4}	1.5×10^{-7}
Lifetime[d] (person-rem)	1.6×10^{-4}	6.5×10^{-8}	8.7×10^{-3}	3.5×10^{-6}

a. Supplemental information provided in Tables C-61 through C-66 in Appendix C.
b. For the offsite maximally exposed individual, probability of a latent fatal cancer; for the population, number of fatal cancers.
c. Annual individual worker doses can be compared with the regulatory dose limit of 5 rem (10 CFR 835) and with the SRS administrative exposure guideline of 0.8 rem. Operational procedures ensure that the dose to the maximally exposed worker will remain as far below the regulatory dose limit as is reasonably achievable. The TE 1995 average dose for all site workers who received a measurable dose was 256 rem (see Table 4-16).
d. Based on 5 years of exposure for current workers and 25 years of exposure for future and uninvolved workers; doses are corrected for radioactive decay.
e. Estimated to be 70 workers.
f. L-Area.
g. L-Area estimated to be 251 workers [Source: Simpkins (1996c)].

over a 5-year career, the involved workers could have 5.5×10^{-5} additional fatal cancer as a result of exposure.

Under the future land use scenario, the combined probability that the involved worker would develop a fatal cancer at some time as the result of a single year's exposure to radiation under the Shut Down and Deactivate Alternative would be 1.6×10^{-5}, or approximately 1 in 100,000. For the total involved workforce, the collective radiation dose could produce up to 1.1×10^{-3} additional fatal cancer as the result of a single year's exposure; over a 25-year career, the involved workers could have 0.021 additional fatal cancer as a result of exposure. TC

The combined annual probability of any individual uninvolved worker developing a fatal cancer as a result of the estimated exposure would be 5.9×10^{-10}. For the total uninvolved workforce, the collective radiation dose could produce up to an additional 1.5×10^{-7} fatal cancer as the result of a single year's exposure; over a 25-year career, the uninvolved workers could have an additional 3.5×10^{-6} fatal cancer as a result of exposure. These impacts would be a small fraction of the natural incidence of cancer from all causes. TC

Nonradiological Impacts

DOE calculated the combined nonradiological health impacts (hazard index) and cancer risks under the current and future land use scenarios for the involved worker. Table 4-67 lists these impacts and risks. The calculated hazard index for the maximally exposed involved worker under the current and future land use scenarios would be a small fraction of 1. Therefore, these individuals would not experience adverse health effects. In addition, the cancer risk to the maximally exposed involved worker would be a small fraction of the natural incidence of cancer from all causes and, therefore, the impact would be minimal. TE

For the uninvolved worker assumed to be in L-Area, the combined hazard index would be a very small fraction of 1 and, therefore, this individual would not experience adverse health effects.

4.3.8.3.3 Shut Down and Maintain

For the Shut Down and Maintain Alternative combined impacts would be the same as described in Section 4.3.8.3.2, Shut Down and Deactivate.

Table 4-67. Combined worker nonradiological hazard indexes and cancer risks associated with the Shut Down and Deactivate Alternative.[a] TE

	No Action		Shut Down and Deactivate	
Receptor(s)	Total hazard index	Annual (lifetime) latent cancer risk	Total hazard index	Annual (lifetime) latent cancer risk
Involved worker (current use)	2.1×10^{-4}	9.1×10^{-9} (4.5×10^{-8})	1.1×10^{-2}	6.6×10^{-8} (3.3×10^{-7})
Involved worker (future use)	5.6×10^{-4}	1.3×10^{-8} (3.1×10^{-7})	2.1×10^{-1}	1.2×10^{-6} (2.9×10^{-5})
Uninvolved worker[c]	1.5×10^{-8}	NA[b] (NA)	1.1×10^{-4}	1.4×10^{-9} (3.6×10^{-8})

TC

a. Supplemental information is provided in Tables C-67, C-68, and C-69 in Appendix C.
b. NA = Not applicable. Nonradiological carcinogens are not released to atmosphere.
c. L-Area.